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A Preliminary Review of Spore Number and Apogamy within the Genus Cheilanthes

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Interesting connections exist among spore number, apogamy, xerophytism, and hybridization. Wagner, Farrar, and Chen (1965) summarized, in a very clear fashion, our knowledge about spores and apogamy. We wish to paraphrase their summary and add other observations: apogamy, which is known in 80 species of ferns, involves no fertilization and new sporophytes grow out of the gametophytes as "buds." Since there is no fusion of gametes, the chromosome numbers of the gametophytes and sporophytes are the same. Usually only eight spore mother cells, instead of 16, are produced in each sporangium, and one division each of the mother cell and of the daughter cells finally produces 32 spores which are usually well-formed and viable. There is a doubling of the chromosomes in the spore mother cells prior to meiosis. After meiosis (reduction) each spore will thus have the same number of chromosomes as that of the sporophyte which produced it, and the spore will produce a gametophyte with the same number of chromosomes as the sporophyte. The presence, then, of 32 spores per sporangium is presumptive evidence that the species involved is apogamous. The most direct evidence of apogamy, of course, would be the observation that the gametophyte lacked archegonia (female sex organs).

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TABLE 1.

Species	*Collector, Number and Source*	*Spore Number*
C. aemula Maxon	Knobloch 2024A; Nuevo Leon, Mex.	64
	Knobloch 1974B; Nuevo Leon, Mex.	64
C. alabamensis (Buckl.) Kunze[2]	Knobloch 2024B; Nuevo Leon, Mex.	32
	Knobloch 1978; Nuevo Leon, Mex.	32
C. californica (Nutt. ex Hook.) Mett.	D. R. Harvey, acc. 63-5; San Diego Co., Cal.	64
	L. Kiefer 1182, acc. 64-9; San Diego Co., Cal.	64
C. castanea Maxon	B. Warnock, acc. 63-60; Davis Mts., Texas	32
	J. K. Baker, acc. 63-49D; Carlsbad Cav. Nat. Park., N. Mex.	32
C. cooperae D. C. Eaton	E. Taylor, acc. 63-18; near La Porte, Cal.	64
C. covillei Maxon	L. Kiefer 1160, acc. 64-6; San Bernardino Co., Cal.	64
C. eatonii Baker	J. K. Baker, acc. 63-49B; Carlsbad Cav. Nat. Park., N. Mex.	32
C. feei T. Moore	F. Rose, acc. 64-14; Whitehall, Montana	32
	Knobloch 1688; El Paso Co., Texas	32
C. fendleri Hook.	Knobloch 1623; Santa Catalina Mts., Arizona	32
C. horridula Maxon	D. S. & H. B. Correll 30762, acc. 65-1; Kinney Co., Texas	64
	Knobloch 2029A; Nuevo Leon, Mex.	64
C. kaulfussii Kunze	Knobloch 884; Chihuahua, Mex.	64
C. lanosa (Michx.) D. C. Eaton in Torr.	Knobloch 1950; Ironto, Va.	64
C. lendigera (Cav.) Swartz	U. Cal. Bot. Gard. 58-046-1, acc. 65-2; Sanitorio Duran, Costa Rica	64
C. leucopoda Link	Knobloch 2025; Nuevo Leon, Mex.	32
C. mexicana Davenport	Knobloch 2075; Chihuahua, Mex.	64
C. notholaenoides (Desv.) Maxon ex Weatherby[2,3]	Lefebure 1284, acc. 64-51; Hidalgo, Mex.	32
C. parryi (D. C. Eaton) Domin	L. Kiefer 1180, acc. 64-4; San Bernardino Co., Cal.	64
	R. Lloyd 2814, acc. 63-12; Inyo Co., Cal.	32
C. pringlei Davenport	Knobloch 1809; Pima Co., Ariz.	64
C. pyramidalis Fée[3]	Knobloch 2127; Durango, Mex.	32
	Knobloch 1881; Chihuahua, Mex.	32
	C. K. Horich, acc. 63-56; Dept. F. Morazan, Honduras	32

Species	*Collector, Number and Source*	*Spore Number*
C. siliquosa Maxon	Thurman's Garden, acc. 63-9; Spokane, Washington	64
	L. Kiefer 1461, acc. 64-19; Humboldt Co., Cal.	64
C. tomentosa Link	Knobloch 2048A; Blount Co., Ala.	32
	D. Moore, acc. 64-16; Ark.	32
	E. Castetter, acc. 63-60; Carlsbad Cav. Nat. Park., N. Mex.	32
C. villosa Davenport ex Maxon	Knobloch 2108; Chihuahua, Mex.	32
C. viscida Davenport	L. Kiefer 1163, acc. 64-1; San Bernardino Co., Cal.	32
C. wootonii Maxon[2]	Knobloch 1698; Santa Catalina Mts., Arizona	32

[2]Reported as apogamous by Dr. Lenette Atkinson (pers. comm. 1966).
[3]Reported as apogamous by Dr. Thomas Pray (pers. comm. 1965).

Occasionally an apogamous species will produce 16 spore mother cells and 64 spores, but the latter are usually inviable. Presumably the production of non-viable spores is due to a lack of chromosome doubling and subsequent lack of chromosome homology and pairing. Such spores lack the balanced number of chromosomes and genes necessary to function properly.

In the genus *Cheilanthes, sensu lato,* the following species have been recorded as apogamous: *C. alabamensis* (Whittier, 1965), *C. bullosa* (*Aleuritopteris b.*) (Mathew in Fabbri, 1965), *C. farinosa* (Manton and Sledge, 1954), *C. feei* (Steil, 1933), *C. hirsuta* (Brownlie in Fabbri, 1965), *C. sieberi* (Brownlie, 1958), *C. tenuifolia* (Verma in Mehra, 1961), and *C. tomentosa* (Whittier, 1965). Dr. Thomas Pray has informed me (pers. comm., 1965) that *C. myriophylla* is also apogamous.

The present study, summarized in *Table 1,* notes eleven more presumptive apogamous ferns in this genus, based mostly on spore count. Since spores are frequently ejected from the sporangia on herbarium sheets, only fresh material was used. Single sporangia were crushed under a cover slip in a drop of mounting medium. Ten slides were made of each species. The accession numbers are mine. Fourteen species in *Table 1* have 32 spores per sporangium and are thus presumed to be apogamous. These, plus six others mentioned above that are not in the table, bring the total in the genus to 20 species.

Cheilanthes parryi has two spore counts, 32 and 64, and presumably has both apogamous and sexual forms. No abortive spores were noted in the 64-spored specimens. Of course, not all apogamous species are obligately apogamous. Some species may be in an evolutionary transitional period and may be facultatively apogamous. Some 64-spored specimens of *C. horridula, C. lanosa, C. mexicana, C. covillei, C. aemula,* and *C. siliquosa* showed a tendency toward spore abortion, i.e., some of their spores were either smaller than others or shrunken.

There are two principal cautions to be observed in interpreting these data: some of the species here reported as apogamous may be found to have sexual forms in localities other than those listed in *Table 1,* or some of the 64-spored species, presumed to be sexual, may prove to be facultatively apogamous in other areas or under other conditions.

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Morphological and Cytological Data on Southeastern United States Species of the Asplenium heterochroum-resiliens Complex

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In a recent issue of this JOURNAL, Wagner (1966) named a new species, *Asplenium heteroresiliens.* This paper supplies morphological and cytological data which support the hypothesis that Wagner's species is the $5x$ hybrid between a $4x$ sexual plant of *A. heterochroum* and an apogamous $3x$ plant of *A. resiliens.*

I am grateful to Mr. Thomas Darling, Jr., of Washington, D. C., who collected plants at Cat Hammock, near Sumterville, Sumter County, Florida, and Dr. E. S. Ford, who sent plants from near Gainesville, Alachua County, and from Columbia County, Florida, about 5 miles northwest of High Springs. These plants were received at the Botanical Gardens of the University of Michigan and grown in the greenhouse under optimum conditions until suitable meiotic stages developed. Chromosome numbers were determined; other observations are summarized in Table 1.

The Alachua County plant, identified as *A. heterochroum,* was a sexual hexaploid, $2n=216$, having 64 haploid spores per sporangium (*Pl. 19D; Pl. 20B, J*). The Sumter County plant, also identified as *A. heterochroum,* was found to be a sexual tetraploid, $2n=144$ (*Pl. 19C; Pl. 20C*). The third plant, from Co-

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